

THE MICRO CLINIC

TRS-80* FLOPPY DISK DIAGNOSTIC

TRS-80* MEMORY DIAGNOSTIC

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Good diagnostic software is a must in diagnosing those occasional system foulups and especially in verifying the long-term reliability of the hardware. THE MICRO CLINIC offers two programs designed to weed out problems in the two most trouble-prone sections of the Model I TRS-80* -- the memory arrays and the disk controller and drives. Both programs are written in Z-80 machine code and are supplied on diskette for a minimum 16K single disk system.

While every attempt has been made to make these diagnostics as complete and as thorough as possible, there may be certain hardware problems in your system which escape detection by these tests. In particular, MOS memory problems can be especially difficult to find due to "pattern sensitivity" in some 16K memory chips. In any case, these two diagnostics together will provide you with a high degree of confidence in the integrity of your system, something we TRS-80* users have needed badly! If you have any questions or suggestions, contact the author, Dave Stambaugh, at THE MICRO CLINIC.

LOADING THE PROGRAMS

The master diskette contains its own loader and CANNOT be read by your DOS software; there is no 'system' or directory on it. To boot the loader, put the master disk in drive 0 and press the "RESET" button at the left rear of the keyboard. After a few seconds, the screen will clear and you will be asked:

LOAD WHICH PROGRAM? (1=FLOPPY, 2=MEMORY)

Select the test you want to run by pressing either "1" or "2". The selected test will begin loading and in a few seconds will announce itself. The master diskette should be removed from the system after the program finishes loading.

TRS-80* FLOPPY DISK DIAGNOSTIC

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FLOPPY DISK DIAGNOSTIC from The Micro Clinic is the most complete diagnostic program available for the Model I TRS-80* disk system, and could be the most important program in your software library. This program provides a positive means for thoroughly checking out the disk controller circuits and disk drives and for verifying the reliability of the entire system. Problems in the disk system can remain "hidden" from the user since the system DOS software performs retries when errors occur. These problems can surface later as data which cannot be accessed or diskettes which can only be read in the same drive they were written on.

From one to four drives can be tested at the same time, 35 or 40 tracks. Three stepping rates are available to test drives at full rated speed. Read/write compatibility between drives can be checked, and tests can be run continuously if desired to test for long-term reliability. Complete and detailed error messages will be reported when errors are detected, and error totals for each drive will be displayed at the end of each pass of the diagnostic.

There are six separate tests in the diagnostic. The purpose of each test is summarized below. A more complete description is given in the "Test Descriptions" section.

- TEST A - Tests the basic controller functions and status bits and checks function of mechanical components (track zero switch, write protect switch, and index pulse sensor).
- TEST B - Verifies that data is being transferred from drive to controller; forces certain error conditions; tests drive seek function.
- TEST C - Performs a single-sector write/read. Data read back is verified byte-by-byte to insure correct data transfer to CPU.
- TEST D - Tests the write/read function across the entire diskette; checks cross-cylinder interference.
- TEST E - Tests the write/read function across the entire diskette using all possible data patterns.
- TEST S - Tests the accuracy of the drive motor speed. Adjustments may be made while the test is running.

FLOPPY DISK DIAGNOSTIC is a stand-alone program, not using or depending in any way on your DOS software.

RUNNING THE DIAGNOSTIC

*** NOTE *** RUNNING THIS PROGRAM REQUIRES THAT A FORMATTED DATA DISK BE INSTALLED IN EACH DRIVE TO BE TESTED. DO NOT USE DISKETTES WHICH CONTAIN PROGRAMS OR DATA YOU WANT TO SAVE -- EVERYTHING (DIRECTORY, DOS, DATA, PROGRAMS) ON THE DISK WILL BE ERASED DURING THE TEST. DISKETTES MUST BE RE-FORMATTED WHEN YOU FINISH RUNNING THE TEST TO MAKE THEM READABLE AGAIN BY YOUR DOS. DO NOT LEAVE THE PROGRAM DISK IN A DRIVE YOU ARE GOING TO TEST, AND DO NOT REMOVE THE WRITE PROTECT TAB FROM THE MASTER PROGRAM DISK!!

After you have selected the FLOPPY DISK DIAGNOSTIC, the program will load, the screen will clear and you will be asked to specify the desired operating parameters. At this time, insure there is a formatted data disk in each drive to be tested and that the program disk is not in Drive 0. When entering parameters, if you accidentally make an incorrect response, enter "↑" (up-arrow) to re-start the questions. In the following descriptions, "(CR)" denotes a question which may require the "ENTER" key to be pressed as the last character entered.

ENTER THE UNITS TO BE TESTED (0-3)? - Enter up to four digits corresponding to which drives you want to test. These unit designations correspond to the standard TRS-80* designations, IE, drive zero is positioned closest to the expansion interface on the connecting cable. For example, to test drives 0 and 1, you would enter "01"(CR). To test all four drives you would enter "0123" (no CR necessary after the 4th character in this case).

HOW MANY TRACKS? (1=35, 2=40) - Enter the number of tracks the drives under test have. For Shugart/RS drives, enter "1" (they have 35 tracks). For MPI, Vista, Pertec, etc., enter "2".

TRACK-TO-TRACK ACCESS TIME? (1=40 MS, 2=20MS, 3=12MS) - This option sets the controller delay between stepping pulses during seeks. The manufacturer's spec for Shugart/RS drives is 40 milliseconds although most will run without problems at 20 milliseconds. Many other drives are rated faster than this. These are the only rates available from the disk controller and may not necessarily correspond exactly to the spec for the drives you are using.

TESTS? (A-E) - Enter the tests you want to run. For example, to run tests A and C, you would enter "AC"(CR). To run all tests enter "ABCDE"(CR). Tests may be run in any order and may be specified more than once, up to a maximum of 50 total characters. If you were to enter "EACDDBA"(CR) one pass of the diagnostic would consist of running those tests in that order on each requested drive. Entering "S" at any time will cause immediate execution of the Speed Test on the first requested drive.

*** NOTE *** RUNNING ANY GIVEN TEST ASSUMES THAT THE TESTS PRIOR TO IT WILL RUN WITHOUT ERRORS, IE, TEST B ASSUMES THAT TEST A WILL PASS, TEST C ASSUMES THAT BOTH A & B WILL PASS, ETC.

RUN CONTINUOUSLY? (Y OR N) - To run the specified tests continuously, enter "Y". If you only want to run through them once, enter "N".

*** NOTE *** IF YOU ARE GOING TO RUN THE TESTS CONTINUOUSLY, YOU SHOULD PROVIDE SOME MEANS OF EXTRA COOLING FOR THE DRIVES, SUCH AS A MUFFIN FAN, TO PREVENT OVERHEATING OF THE POWER SUPPLIES.

TERMINATE TEST ON EXCESSIVE ERRORS? (Y OR N) - This option provides for recovery from "endless" error loops. If answered "Y" all testing would terminate after 10 errors of any type have accumulated. For example, the test would terminate after 10 seek errors or 10 CRC errors. If this option is answered "N" testing will continue regardless of the number of errors accumulated. This option does not affect any part of Test A or portions of Test B where error conditions are forced or where drive components are tested--errors in these areas are always considered fatal and cause testing to be suspended.

OPERATOR INTERVENTION? (Y OR N) - Portions of Test A and the diskette interchangeability test require that this option be answered "Y". If this option is answered "N" the write protect and index sensors are not completely checked out. This option will be automatically disabled after the first pass of the test.

TEST DISKETTE INTERCHANGEABILITY? (Y OR N) - If the previous question was answered NO, this question is skipped. When this question is answered "Y" and when tests D or E have been requested, the operator will be prompted to remove the diskette from the drive under test and insert it in another drive (after writing on it) to test drive-to-drive compatibility. This option will be automatically disabled after the first pass of the test.

*** NOTE *** AFTER A DISKETTE HAS BEEN READ-VERIFIED IN A DIFFERENT DRIVE, THE PROGRAM WILL PROMPT THE USER TO PUT IT BACK IN ITS ORIGINAL DRIVE. AT THIS TIME BE SURE TO PUT ALL DISKETTES BACK IN THEIR ORIGINAL DRIVES BEFORE CONTINUING.

TEST DESCRIPTIONS

TEST A - This test checks for proper operation of mechanical components in the drives and tests the most basic controller functions. The operator is prompted to open the door of the current drive and pull out the diskette slightly. This trips the write-protect switch and prevents detection of an index pulse. The drive should also

be sensed 'not ready' at this time. The drive is then selected; 'ready' should be sensed, as should write protect. Index should not be sensed. If no errors so far, the operator is prompted to put the diskette back and close the door. The drive is selected and a Restore command is given. After executing a timing loop, the 'busy' bit should not be active; track zero should be sensed and the track register should contain '0'. A step-in command is given; track 0 should be sensed again, and the track register should indicate we are on track 1 now. A step-out command is given; track 0 should be sensed again, and the track register should again contain '0'. A seek is made to the last track on the disk; at the end of a timing loop, the controller should indicate the operation is complete and the track register should have been correctly updated.

*** NOTE *** IF OPERATOR INTERVENTION WAS NOT SELECTED, WRITE PROTECT AND INDEX PULSE SENSE ARE NOT COMPLETELY CHECKED. THE RESTORE/STEP IN/STEP OUT SEQUENCE IS VERY IMPORTANT IN CHECKING FOR PROPER ADJUSTMENT OF THE TRACK 0 SWITCH: IF IT IS MISALIGNED OR DEFECTIVE IT CAN DRIVE THE DOS CRAZY!

TEST B - This test will first perform a Restore. A read-track-address command will then be given. Upon completion of a delay loop, 'DRQ' should be sensed. If not, either data is not being transferred from the drive to the controller, or your diskette is not formatted! A 'lost data' error should also have occurred. The track register is then loaded with a value not corresponding to the track the head is actually positioned over (which is track zero). A 'read sector' command is given which should cause a 'record not found' error. A multiple-sector I/O transfer is then attempted. Proper operation of the 'seek' function is now tested. Two counters are used to determine the track number -- counter A starts at zero and increments, counter B starts at the highest track number and decrements. The seeks are done using verification to insure correct head positioning. This series of seeks will result in a damped oscillation across the disk, settling at midpoint. All possible length seeks in each direction will be performed. Test B is important in checking for binding or other problems in some drives, especially after a lot of use. The head carriage mechanism can become so dirty that it causes the cam follower to slip out of its groove causing the head to "get lost" during seeks.

TEST C - This test will check the write and read commands by writing an alternating AA/55 pattern to sector 0 of track 0. The sector will then be read back and verified byte-by-byte to insure correct data transfer from the data bus drivers to CPU. Errors caused either by controller flags or by unexpected data will be listed out, showing the expected and actual data in hexadecimal form.

TEST D - This test will perform a write/read across the entire disk. Cross-cylinder interference (writing on one track causing data interference on an adjacent track) is checked by writing alternating tracks of ones and zeroes. Diskette interchangeability may be checked as described under that test option. Data transfer is done a single sector at a time with complete error checking after each transfer.

TEST E - This test performs a write/read operation across the entire disk using all possible data patterns. Diskette interchangeability may be checked if desired. Complete error checking is done after each sector transfer.

TEST S - This tests the accuracy of the drive motor speed on the first requested drive. The results are continuously monitored and displayed on the screen. The allowable error is $\pm 0.33\%$ from the nominal value of 300 RPM. Adjustments may be made while the test is running. To exit this test, hold down the "ENTER" key.

*** NOTE *** INACCURATE MOTOR SPEED IS THE MOST COMMON CAUSE OF ERRORS DURING TESTS D & E, ESPECIALLY ON THE HIGHER (INNER) TRACKS. ON SHUGART/RS DRIVES, THE SPEED ADJUSTMENT POT IS ON THE SMALL CIRCUIT BOARD AT THE REAR OF THE DRIVE. DO NOT ADJUST THE POT ON THE LARGE CIRCUIT BOARD ON THE SIDE OF THE DRIVE! YOU MAY WANT TO LET THE TEST RUN FOR A MINUTE OR SO TO ALLOW THE SPEED TO STABILIZE.

ERROR HANDLING

Error messages are printed out any time the diagnostic detects an error or abnormal condition. Errors in Test A and portions of Test B are considered fatal and will cause termination of testing. Other errors will be reported by type, with track and sector information printed out in hexadecimal.

TERMINATING THE TEST

The diagnostic may be terminated at any time by holding down the "ENTER" key. An opportunity will be given to restart the test or to boot DOS.

OWNERS OF 40-TRACK DRIVES

Radio Shack* elected to save a buck on the cost of the expansion interface by utilizing the internal data separator circuits of the controller chip rather than adding an external separator in spite of the fact that Western Digital specifically warns against this. This problem manifests itself as persistent errors on the inner tracks. Percom manufactures a board called "The Separator" which plugs into the EI and should cure this problem.

ERROR MESSAGES AND POSSIBLE CAUSES

***** ERROR MESSAGE *****	** POSSIBLE CAUSE **
DRIVE SENSED READY WHEN NOT SELECTED	K,M
WRITE PROTECT NOT SENSED	D,G,K,M,N
BUSY FLAG NOT SENSED	G,K,M
DRIVE NOT READY	K,M,N
INDEX MARK SENSED WHEN NOT EXPECTED	C,K,M,N
INDEX MARK NOT SENSED	A,C,K,M,N
WRITE PROTECT SENSED	D,G,K,M,N
CONTROLLER EXCEEDED TIME LIMIT FOR OPERATION	G,K,M
TRACK REGISTER IS NOT BEING UPDATED	G,K,M
TRACK 0 NOT SENSED CORRECTLY	B,D,E,G,K,M
DATA IS NOT BEING TRANSFERRED TO CONTROLLER	F,J,K,M
FORCED RECORD-NOT-FOUND ERROR DID NOT OCCUR	K,M
FORCED LOST DATA ERROR DID NOT OCCUR	K,M
FAILED MULTIPLE-SECTOR I/O OPERATION	F,H,K,M
DATA READ FROM DISK IS INCORRECT	K,M
RECORD NOT FOUND	F,H,I,J,K,L,M
SEEK ERROR	B,E,H,I,J,K,L,M
CRC ERROR	F,H,I,J,K,L,M
LOST DATA	F,H,I,J,K,L,M

A = DRIVE MOTOR BAD
 B = STEPPER MOTOR BAD
 C = INDEX MARK SENSOR BAD
 D = SWITCH MISALIGNED OR BAD
 E = HEAD CARRIAGE BINDING (DIRTY OR WORN)
 F = HEAD LOAD PAD WORN OR MISSING
 G = EXPANSION INTERFACE CLOCK BAD
 H = DISKETTE DEFECTIVE OR NOT FORMATTED
 I = HEAD MISALIGNED (USUALLY SHOWS UP WHEN TESTING COMPATIBILITY)
 J = DRIVE WRITE/READ BOARD BAD
 K = EXPANSION INTERFACE CONTROLLER/INTERFACING CIRCUITS BAD
 L = DRIVE MOTOR SPEED OUT OF TOLERANCE
 M = CABLES BAD OR EDGE CONNECTORS DIRTY
 N = OPERATOR ERROR -- READ INSTRUCTIONS AGAIN!!

TRS-80* MEMORY DIAGNOSTIC

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The Memory Diagnostic is a comprehensive test of the memory arrays in the keyboard and expansion interface. After the program loads, the screen will clear and the user will be asked to enter test parameters as follows:

ENTER SYSTEM MEMORY SIZE? (1=16K, 2=32K, 3=48K) -- Enter the appropriate total memory size for your system, including the expansion interface. For example, if you have 16K in the expansion interface, your total memory size is 32K and you would enter '2' (16K in keyboard + 16K in the interface).

PAUSE ON ERRORS? (Y OR N) -- If you want the diagnostic to pause whenever an error occurs, enter 'Y'. This is useful whenever a great number of errors are occurring since they will scroll off the screen faster than you can read them. If errors are infrequent or non-existent you may want to enter 'N'. Whenever the test pauses after an error, you may resume the test by pressing 'Y' to retain the pause-on-error mode. Pressing any other key will disable the pause-on-error mode of operation.

RUN M-1 WORM TEST? (Y OR N) -- It is not recommended that you run this test until you are sure your system will run the conventional write/read tests without error. Because this test actually executes machine code from the memory being tested, the results can be somewhat unpredictable sometimes. For details on this test, see the description which follows. Enter 'Y' to run the test, or 'N' to suppress it.

A flashing graphics block in the upper right corner of the display indicates that the program is running; the M-1 Worm test is indicated by a 'W'. The larger the memory, the slower the test will run. One pass of the test on a 48K machine, with the M-1 Worm option, will take about 2 hours. At the end of each complete pass, the total passes and the cumulative error count will be printed out. The most desirable way to test your system for long-term reliability is to allow it to run the diagnostic overnight as a minimum, and longer if possible. Many manufacturers of computer equipment run diagnostics for 72 hours straight, sometimes at elevated temperatures.

TEST DESCRIPTIONS

The Memory Diagnostic is broken down into two basic tests, the conventional write/read test and the M-1 Worm test.

WRITE/READ TEST -- This portion of the diagnostic performs a comprehensive check on the ability of each memory location to store data. The test is broken down into 5 basic pattern tests; each of these tests runs as follows: the address under test is written into and immediately read back to insure accuracy. This continues on through the array. Then each address is re-checked to insure 1) data integrity is maintained over a period of time (refresh) and 2) accessing any particular address does not alter data in any other address. One pass of the diagnostic will have tested each address 2560 times using every possible data pattern.

M-1 WORM TEST -- This test attempts to execute a short block of machine code from the memory under test. First the entire test area is filled with X'FF'. Then a special 6-byte block of code is written into the first 6 locations and is executed. If this works, the 6-byte block will be moved up 1 address, the byte immediately preceding the block will be changed to X'FF', and the block is executed again. This continues, moving the block up 1 address each time, until it has moved throughout memory. Some Z-80 based machines have experienced difficulties running a test such as this due to timing problems.

ERROR HANDLING

Errors are handled differently depending on whether the write/read test failed or the 'M-1 Worm' test failed.

ERRORS IN WRITE/READ TEST -- An error in this portion of the test will cause an error message to print out with the following information in hexadecimal: the error address, followed by the expected data and the actual data. The cumulative error count will be incremented once for each error that occurs. A typical error message might be as follows:

ERROR: ADDRESS=A045 EXPECTED DATA=55 ACTUAL DATA=5D

See the section on Troubleshooting Hints for help in interpreting error messages.

ERRORS IN THE M-1 WORM TEST -- Errors in this test can be much more tricky to handle. Because we are attempting to actually execute machine code from the address under test, the results can be unpredictable if the machine attempts to execute an unexpected instruction or a non-valid one. This is the reason for filling all addresses with X'FF'; if the CPU pulls the instruction from one of these addresses rather than the 6 we are actually trying to test,

it would execute a RST 38H instruction which would turn over control to a ROM-based 'trap' routine. If this occurs, or if any other error occurs, an error message will appear such as this:

```
***** ERROR IN M-1 WORM TEST *****
ADDRESS OF 1st BYTE OF CODE = ZZZZ
EXPECTED CODE AT TEST ADDRESS = 7D 55 AA C3 97 41
ACTUAL CODE AT TEST ADDRESS   = XX XX XX XX XX XX
```

'ZZZZ' represents the address of the 1st byte of the 6-byte block; 'XX' would equal the actual code at the test addresses at this time and may or may not match the expected data. If the system fails this test but will not print out any error message (for example, it reboots, or does something else crazy) you should try running the write/read test alone for a long period.

TROUBLESHOOTING MEMORY PROBLEMS

It is not possible to document here every possible cause of memory problems in the system; only the most common problems will be discussed. If the system fails the diagnostic, and you do not want to attempt to troubleshoot it yourself, take it in for repair along with the error information provided by the diagnostic.

*** NOTE *** IF YOU OPEN THE KEYBOARD OR THE EXPANSION INTERFACE,
YOU VOID THE WARRANTY!!!

For the purpose of this discussion, the TRS-80* contains 3-16K memory arrays; we will refer to each of these arrays as a 'page'. The 3 pages of memory in the system are addressed and physically located as follows:

```
PAGE 1 - ADDRESSES X'4000' to X'7FFF' -- located in keyboard
PAGE 2 - ADDRESSES X'8000' to X'BFFF' -- located in exp intf
PAGE 3 - ADDRESSES X'C000' to X'FFFF' -- located in exp intf
```

The IC's which make up these pages and the associated data bits are:

	D7	D6	D5	D4	D3	D2	D1	D0	
PAGE 1	Z13	Z14	Z20	Z15	Z19	Z18	Z16	Z17	*** In Keyboard
PAGE 2	Z09	Z10	Z11	Z12	Z13	Z14	Z15	Z16	### In Exp Intf
PAGE 3	Z01	Z02	Z03	Z04	Z05	Z06	Z07	Z08	### In Exp Intf

Using the error example given previously, the error address was X'A045', the expected data was X'55', and the actual data was X'5D'. In this case, the error occurred in page 2 of memory. The actual data indicates that we picked up data bit 3.

DATA BITS	7	6	5	4	3	2	1	0
X'55'	=	0	1	0	1	0	1	1
X'5D'	=	0	1	0	1	1	1	1

From the charts, we can see that the memory chip for data bit 3 in Page 2 is Z13 in the expansion interface. The reference designations are silkscreened on the PC board by each socket.

*** NOTE *** MOS MEMORY CHIPS ARE VERY SENSITIVE TO STATIC ELECTRICITY AND ARE EASILY DAMAGED BY IMPROPER HANDLING!!

If this were the only bit failing, you could try swapping the suspect IC with another one which is not failing. If the error moves to the new location, you have probably found the bad memory chip. If the error persists at the same location, or if you have multiple bad bits or cannot otherwise determine any other logical pattern to the errors occurring, you should probably take the unit in for repair.

Keep in mind that your system may fail even though there is nothing technically wrong with it. For example, if you are in an electrically 'noisy' environment such as an office with copy machines or other electrical equipment, the TRS-80* can pick up 'glitches' from the AC line causing random errors. A line filter may be helpful under these conditions.

ALL SOFTWARE IS SOLD ON AN AS-IS BASIS WITHOUT WARRANTY. The Micro Clinic assumes no liability for loss or damage caused or alleged to be caused directly or indirectly by products sold by it or its distributors, including but not limited to any interruption in service, loss of business or anticipatory profits or consequential damages resulting from use or operation of such products.

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OWNER REGISTRATION

Please take the time to fill out and send in the registration form below. As a service to purchasers of these diagnostics, if something should happen to the master diskette which makes it unreadable or otherwise damages the software, THE MICRO CLINIC will re-copy the programs onto the diskette for a \$5.00 charge for postage and handling. THIS OFFER APPLIES ONLY TO REGISTERED OWNERS. THE ORIGINAL MASTER DISKETTE MUST BE RETURNED TO THE MICRO CLINIC. THIS OFFER DOES NOT APPLY TO DISKETTES WHICH HAVE BEEN MIS-HANDLED OR DAMAGED. When returning diskettes through the mails, please provide adequate protection such as putting the diskette between two pieces of cardboard inside a suitable mailer.

Mail to: THE MICRO CLINIC
17375 Brookhurst #114
Fountain Valley, CA 92708

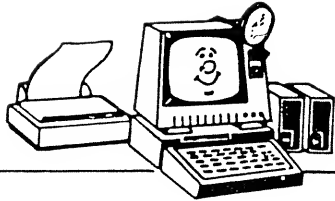
NAME: _____

ADDRESS: _____

CITY: _____

STATE: _____ ZIP: _____

PURCHASED FROM: _____



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ADDENDUM TO INSTRUCTIONS

ENHANCEMENTS HAVE BEEN MADE TO BOTH DIAGNOSTICS WHICH ENABLE THEM TO DO AN EVEN MORE THOROUGH JOB TESTING YOUR SYSTEM. THESE CHANGES ARE REFLECTED IN VERSION 2.2 OF THE FLOPPY DOCTOR, AND VERSION 2.1 OF THE MEMORY DIAGNOSTIC.

THE FLOPPY DOCTOR - A SECOND SEEK TEST HAS BEEN ADDED TO TEST B (IN ADDITION TO THE "DAMPED OSCILLATION" TEST) WHICH MAY HELP EXPOSE MECHANICAL PROBLEMS SUCH AS EXCESSIVE WEAR, "PLAY", OR BINDING IN THE HEAD POSITIONING HARDWARE. A SERIES OF SEEKS WILL BE PERFORMED USING THE FOLLOWING PATTERN: 0 TO 2, 2 TO 1, 1 TO 3, 3 TO 2, 2 TO 4, ETC. IN THIS MANNER, EACH TRACK WILL BE APPROACHED FROM BOTH DIRECTIONS OVER A SHORT DISTANCE, WITH CORRECT HEAD POSITIONING VERIFIED EACH TIME.

TESTS D AND E HAVE BEEN ENHANCED BY ADDING A "READ REVERSE" TEST WHICH IS PERFORMED FOLLOWING THE READ IN THE "FORWARD" DIRECTION. EACH TRACK IS READ IN REVERSE ORDER; SECTORS WITHIN EACH TRACK ARE ALSO READ IN REVERSE ORDER. THIS TEST INSURES THAT EACH TRACK CAN BE READ PROPERLY WHEN APPROACHED FROM EITHER DIRECTION.

MEMORY DIAGNOSTIC - SEVERAL ENHANCEMENTS HAVE BEEN MADE TO THE MEMORY DIAGNOSTIC. THE WRITE/READ SECTION HAS BEEN COMPLETELY SEPARATED FROM THE "M-1 WORM" TEST; THE CODE FOR THIS SECTION HAS BEEN STREAMLINED CONSIDERABLY, CAUSING THE PROGRAM TO EXECUTE IN LESS TIME. ONE PASS OF THIS TEST WILL CHECK EACH ADDRESS 520 TIMES VS. 2560 IN VERSION 2.0. HOWEVER, IF THIS TEST WERE RUN FOR THE SAME LENGTH OF TIME, EACH ADDRESS WOULD BE TESTED ABOUT THE SAME NUMBER OF TIMES. AS THE TEST PROGRESSES, THE USER WILL BE KEPT INFORMED OF ITS PROGRESS AT ALL TIMES; A COUNTER ON THE SCREEN WILL INCREMENT FROM X'00' TO X'FF' AND THE DISPLAY WILL ALSO SHOW WHETHER THIS IS THE WRITE/READ OR THE VERIFY PASS. WHEN AN ERROR OCCURS, IN ADDITION TO PRINTING OUT THE ERROR ADDRESS, EXPECTED DATA, AND ACTUAL DATA, THE PROGRAM WILL PROVIDE DETAILED ERROR ANALYSIS. THE FAILING BIT (OR BITS), THE CORRESPONDING IC (OR IC'S) AND THEIR LOCATION (WHETHER IN KEYBOARD OR EXPANSION INTERFACE) ARE ALSO LISTED.

THE "M-1 WORM" TEST (WHEN SELECTED) RUNS AFTER COMPLETION OF THE WRITE/READ TEST. AS IT IS RUNNING, THE ADDRESS OF THE 1ST OF THE 6 TEST BYTES WILL BE DISPLAYED ON THE SCREEN TO KEEP THE USER INFORMED OF ITS PROGRESS THROUGH MEMORY. THE TEST WILL RUN 3 CONSECUTIVE TIMES.

A "RELOCATION TEST" HAS BEEN ADDED TO TEST LOW MEMORY WHERE THE DIAGNOSTIC ITSELF IS NORMALLY LOCATED. THE PROGRAM WILL BE RELOCATED OUT OF THE WAY TO HIGH MEMORY. LOW MEMORY IS CHECKED, AND THE PROGRAM WILL RELOCATE ITSELF BACK WHERE IT BELONGS. THIS COMPLETES A PASS OF THE DIAGNOSTIC; THE NUMBER OF PASSES AND CUMULATIVE ERRORS WILL THEN BE PRINTED OUT ON THE SCREEN.